Missouri Department of Natural Resources

Biological Assessment and Habitat Study Report

Long Branch
Johnson and Pettis Counties

September 2007 – March 2008

Prepared for:

Missouri Department of Natural Resources
Division of Environmental Quality
Water Protection Program
Water Pollution Control Branch

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1.0 Introduction

At the request of the Water Protection Program (**WPP**), the Environmental Services Program's (**ESP**) Water Quality Monitoring Section (**WQMS**) conducted a biological and habitat assessment of Long Branch, Johnson and Pettis Counties. Long Branch flows through a primarily rural landscape in west central Missouri.

A 3.5-mile section of Long Branch was listed as impaired on the 2002 303(d) list for unknown pollutant(s) and unknown source(s) by the U. S. Environmental Protection Agency (**USEPA**). Long Branch is one of nine Missouri streams listed by USEPA for unknown pollutants and sources. No specific reason is given for listing Long Branch.

On July 19, 2007 a study plan was submitted to the WPP (see Appendix A). See Section 1.4 for the null hypotheses stated in the study plan. Null hypotheses for biological and habitat assessment are included in this study.

1.1 Purpose

The purpose of this study was to determine if the Long Branch macroinvertebrate community and/or stream habitat were impaired and, if so, determine the possible causes.

1.2 Objectives

- Determine if the macroinvertebrate community of Long Branch is impaired.
- Determine the habitat characteristics of Long Branch.
- Define the water quality characteristics of Long Branch.

1.3 Tasks

- Conduct a biological assessment of the macroinvertebrate community of Long Branch.
- Conduct a habitat assessment of Long Branch.
- Conduct a water quality assessment of Long Branch.

1.4 Null Hypotheses

- Macroinvertebrate assemblages are similar between Long Branch and biocriteria reference (**BIOREF**) streams.
- Macroinvertebrate assemblages are similar among Long Branch stream segments.
- Macroinvertebrate assemblages will not differ significantly between the two sample seasons.
- Habitat quality is similar among Long Branch stream segments.
- Habitat quality is similar between Long Branch and biocriteria reference streams.

2.0 Study Area

Long Branch originates just southwest of Whiteman Air Force Base (**WAFB**) near Knob Noster in Johnson County. It flows predominantly east through its watershed of rural grassland and cropland (Table 2) until its confluence with Muddy Creek in western Pettis County.

According to Chapter 7 of the State of Missouri Water Quality Standards (10 CSR 20-7.031), a 5.3-mile classified segment from sec. 6, T. 45 N., R. 23 W. to its confluence with Muddy Creek at sec. 34, T. 46 N., R. 23 W. is designated class "P" and the remaining upstream 4.5-mile segment is designated as class "C". Beneficial use designations are for "livestock and wildlife watering, protection of warm water aquatic life and human health—fish consumption, and whole body contact recreation B". The 303(d) listed 3.5-mile segment overlaps the two separate classifications.

Long Branch is located within the Central Plains/Blackwater/Lamine Ecological Drainage Unit (**EDU**). An EDU is a region in which biological communities and habitat conditions can be expected to be similar. See Appendix B for a map of EDUs and the 14-digit Hydrologic Units (**HU**) that contain the sampling reaches for Long Branch. See Table 2 for a comparison of land use for the EDU and the 14-digit HUs.

2.1 Water Quality Concerns

The upper portion of Long Branch flows through Whiteman Air Force Base where station #2 is located. The stream is typically dry where it runs into a culvert at the western edge of the south end of the airfield (see map Appendix B). There is flow when the stream emerges from the downstream end of the culvert on the southeast side of the airfield. The source of the flow is unknown. Possible sources of water quality impacts that can come from a military air base include treated wastewater and airbase runoff including de-icing agents.

Agricultural activity dominates the landscape in the plains regions of Missouri, including the Long Branch basin. This includes row crops and cattle pasture as well as confined animal feeding operations (**CAFO**). Erosion of agricultural land is a major cause of sediment deposition in many rural Missouri streams. Oftentimes row crops are planted to the edge of stream banks, thus eliminating stabilizing riparian vegetation. This causes the banks to become unstable, steep, and without shade, resulting in higher summer water temperatures and loss of habitat. A major egg producing facility is located immediately upstream of station #1. There are also two permitted subdivision wastewater treatment facilities in the study drainage area.

2.2 Long Branch Site Descriptions

Two sampling locations were selected for this study. Sample stations were located in Johnson and Pettis Counties (see map Appendix B). The average width and discharge

measurements in cubic feet per second (**cfs**) during both survey periods are given for each Long Branch sampling station in Table 1.

The sample stations are typical of the northern portion of the Central Plains/Blackwater/Lamine EDU with predominantly clay and sand bottom, some fine silt, and little if any rock or gravel substrate.

Long Branch Station #1 (E ½ sec. 6, T. 45 N., R. 23 W.) is located just downstream of Thompson Road which is along the Johnson/Pettis County line. The station is on the Pettis County side of the crossing and in the class "P" section of the stream. Geographic coordinates at the upstream terminus of this station are UTM Zone 15, E 456172, N 4285525.

Long Branch Station #2 (sec. 2, T. 45 N., R. 24 W.) is located in the southwest corner of WAFB in Johnson County and is in the class "C" section of the stream. Geographic coordinates at the downstream terminus of this station are UTM Zone 15, E 453540, N 4285549.

Table 1
Physical Characteristics of Long Branch Stations

Long Branch Station #	Average Width (feet)	Fall 2007 Flow (cfs)	Spring 2008 Flow (cfs)
1	12.4	0.23	0.50
2	15.0	*	0.19

* Discharge too low for measurement

3.0 Methods

Fall sampling at Long Branch was conducted on September 25, 2007 (station #2) and September 27, 2007 (station #1). Spring sampling was conducted on March 24, 2008. Sampling was conducted by Brian Nodine and Mike Irwin of ESP. Sampling consisted of macroinvertebrate collection and water quality sampling. Habitat assessments and quantitative channel measurements on Long Branch as well as a BIOREF station on East Fork Crooked River were conducted during the fall 2007 sampling season.

3.1 Habitat

Sedimentation is only one of several instream habitat problems associated with land use. Other instream habitat features can be directly measured, yet the causes of habitat degradation can range from local to watershed scale sources. For this study, habitat measurements were collected at the watershed, reach, and local scales to facilitate assessment of the potential causes of poor habitat conditions.

3.1.1 Land Use

Land cover data were derived from the Thematic Mapper satellite data from 2001-2004, and interpreted by the Missouri Resource Assessment Partnership (**MoRAP**). See Section 2.0, Section 5.1, and Table 2 for land use information.

3.1.2 Habitat Assessment

A standardized habitat procedure for Glide/Pool stream types was followed in the Stream Habitat Assessment Project Procedure (**SHAPP**) (MDNR 2003b).

3.1.3 Sinuosity

Sinuosity was used as a rough indicator of the amount of channelization that has occurred. Sinuosity was measured using the National Hydrography Dataset (**NHD**) of the stream segment and is represented as a ratio of the actual stream segment length compared to the straight-line distance between two points. Measurement points were approximately two miles apart with the sampling reach at the center.

3.1.4 Instream Width and Depth Measurements

It is typical for streams in rural, agricultural Missouri to suffer from a lack of instream habitat due to poor land use and channelization. These streams trend toward wider channels with shallower water depths and more homogeneous habitat (Haithcoat et al. 2003c). At each sampling station a series of ten bank to bank transects were established. Each transect was equally spaced within the sampling reach, which was 20x the average width. Measurements taken at each transect included lower bank width (see SHAPP for a definition of lower bank), wetted width, and water depth at 1/3, 1/4, and 2/3 of the distance across the wetted width. To document critical habitat conditions, measurements were collected during the fall low flow period.

3.2 Physicochemical Data Collection and Analysis

During each survey period, *in situ* water quality measurements were collected at all stations for temperature (°C), dissolved oxygen concentration (mg/L), conductivity (µS/cm), and pH. These measurements followed Standard Operating Procedures MDNR-FSS-101 Field Measurement of Water Temperature (MDNR 1993), MDNR-WQMS-103 Sample Collection and Field Analysis for Dissolved Oxygen Using a Membrane Electrode Meter (MDNR 2002b), MDNR-FSS-102 Field Analysis for Specific Conductance (MDNR 2000a), and MDNR-FSS-100 Field Analysis of Water Samples for pH (MDNR 2001a) respectively. Additionally, water samples for chloride, total phosphorus, ammonia-N, nitrate + nitrite-N, and total nitrogen were collected for analyses by ESP's Chemical Analysis Section (**CAS**). Turbidity (NTU) was collected and analyzed by the WQMS.

Stream discharge in cubic feet per second (**cfs**) was measured at each sampling station using a Marsh-McBirney Flo-Mate Model 2000. Discharge was calculated per the methods in the Standard Operating Procedure MDNR-FSS-113, Flow Measurement in Open Channels (MDNR 2001b).

Physicochemical data were summarized and presented in tabular form for comparison among the two Long Branch stations and between sample seasons.

3.3 Macroinvertebrate Collection and Analysis

A standardized sample collection procedure was followed as described in the Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (**SMSBPP**) (MDNR 2003a). The three standard glide/pool stream habitats of non-flowing water with depositional substrate (**NF**), large woody debris (**SG**), and rootmat (**RM**) at the stream edge were sampled at all locations.

A standardized sample analysis procedure was followed as described in the SMSBPP. The SMSBPP provides details on the calculation of metrics and scoring of the multi-metric Macroinvertebrate Stream Condition Index (**MSCI**). The following four metrics were used: 1) Taxa Richness (**TR**); 2) total number of taxa in the orders Ephemeroptera, Plecoptera, and Trichoptera (**EPTT**); 3) Biotic Index (**BI**); and 4) Shannon Diversity Index (**SDI**).

Macroinvertebrate data were analyzed in three specific ways. First, Long Branch stations were compared to biological criteria for the Central Plains/Blackwater/Lamine EDU. Second, a longitudinal comparison between the two Long Branch sites was performed. Finally, a comparison was made of Long Branch data between fall and spring sampling seasons. See Tables 10 and 11 for biological criteria for warm water reference streams in the Central Plains/Blackwater/Lamine EDU for the fall and spring index periods.

4.0 Quality Assurance/Quality Control (QA/QC)

QA/QC procedures were followed as described in pertinent Standard Operating and Project Procedures.

5.0 Data Results and Analyses

5.1 Land Use

According to MoRAP land cover files (Table 2), the watershed land use of Long Branch is mostly comprised of an equal mix of grassland and cropland. A small area of the land in the Long Branch drainage is urban, forest, wetland, or open water. The majority of land use of the reference watershed is cropland and grassland.

Table 2
Percent Land Cover

Watershed	Urban	Cropland	Grassland	Forest	Wetland	Open Water
Central Plains/ Blackwater/Lamine EDU	7	38	31	18	-	-
14-digit HUC 10300103040002 Long Branch Site 1 and Site 2	3	40	41	11	1	0

5.2 Habitat Assessment

Habitat assessment scores were recorded for each sampling station. Results are presented in Table 3. According to the project procedure guidance, the total score from the physical habitat assessment of the study sites should be at least 75% of the total score of the habitat assessment(s) of a BIOREF station(s) to support a similar biological community. Habitat scores for the two Long Branch stations were compared with an East Fork Crooked BIOREF station habitat assessment conducted the same season. Both Long Branch stations exceeded the 75% threshold so it is therefore inferred that, based on habitat scores, they should support comparable biological communities.

Table 3
Habitat Scores (Fall 2007)

BIOREF Habitat Score East Fork Crooked River	Long Branch Station #	Habitat Score	% of Locust Cr. BIOREF
103	1	88	85
	2	107	104

5.3 Sinuosity and Riparian Zone Condition

Characteristics for each sampling station are listed in Table 4. Sinuosity was calculated for each station by choosing points on the stream approximately two miles apart, with the sampling station in the approximate center of the reach. Sinuosity ratios are calculated by comparing the stream distance between two points to the direct spatial distance between the same two points. The higher the sinuosity ratio, the less likely the stream segment is channelized. The sinuosity ratio was 1.66 on the BIOREF East Fork Crooked station indicating an unlikelihood of channelization. Long Branch sinuosity ratios were 1.48 and 2.2 at stations 1 and 2, respectively, also indicating an unlikelihood of channelization. Regardless of the sinuosity ratios, visual observations of a map of Long Branch do indicate channelization at station #2. The general shape of the channel along the sampling station is straight with an approximate 90º bend at the upper end with much of that portion of the stream bank reinforced with rip-rap (see Appendix B).

Riparian zone conditions derived from SHAPPs conducted in the fall at Long Branch ranged from good at station #1 to mixed conditions at station #2 and the East Fork BIOREF station.

Table 4
Sinuosity and Riparian Zone Condition

Station	Sinuosity	Likely to be channelized	Riparian Zone Condition
Long Branch 1	1.48	Yes*	Good
Long Branch 2	2.20	No	Mixed**
East Fork Crooked	1.66	No	Mixed**

* Based on visual observations. See Sec. 5.3
** Left bank good, right bank poor

5.4 Stream Width and Depth Measurements

Transect measurements for average channel width (= lower bank width), average wetted width, average stream depth, maximum depth, and standard deviation for depths of Long Branch stations are represented in Table 5. Overall average values and ranges from selected BIOREF stations are also presented. The BIOREF data represent an average of four stream channel measurements; three from the Central Plains/Blackwater/Lamine EDU and one from the adjacent Ozark/Moreau/Loutre EDU. Channel width to wetted width and wetted width to depth ratios are also presented. The ratios allow for standardization of channel measurements for longitudinal comparisons. Channel width typically widens as a stream proceeds downstream. These ratios allow channel widths and depths to be compared along a stream reach.

Average channel width, average wetted width, and average depth measurements for both Long Branch sites indicate a smaller stream than the measurements of the four BIOREF stations as they fall well below the ranges of those of the BIOREFs. Maximum depth measurements either fall within the lower end of the range for those of the BIOREF stations as at station #1 or well below the range as at station #2.

Standard deviations of depths for the Long Branch stations were higher than those of the BIOREF stations, indicating comparable or better heterogeneity of depths on Long Branch.

The ratios of average channel width to average wetted width and wetted width to depth for the Long Branch stations were not noticeably different from, and fell within the ranges of, the ratios for the BIOREF stations. These ratios indicate a lack of a tendency toward a wider and shallower stream.

Table 5
Channel Dimensions

Station	Average Channel Width (ft.)	Average Wetted Width (ft.)	Average Depth (ft.)	Maximum Depth (ft.)	Standard Deviation of Depth	Channel Width/Wetted Width	Wetted Width/Depth
Long Branch 1	9.8	8.4	0.6	2.3	0.53	1.17	15.23
Long Branch 2	13.3	11.4	0.6	1.4	0.32	1.16	17.75
BIOREF L. Drywood #1	48.1	21.5	1.1	2.2	0.5	2.2	20.0
BIOREF L. Drywood #2*	37.1	16.0	0.8	1.8	0.3	2.3	18.7
BIOREF E. Fk. Crooked	24.7	15.6	1.1	2.0	0.4	1.6	14.3
BIOREF** Petite Saline	28.2	21.3	2.3	6.5	1.5	1.3	9.4
BIOREF average	34.5	18.6	1.3	3.1	0.7	1.8	15.6
BIOREF range	24.7-48.1	15.6-21.5	0.8-2.3	1.8-6.5	0.3-1.5	1.3-2.3	9.4-20.0

* From Class "C" segment of stream.

** All BIOREF Central Plains/Blackwater/Lamine EDU except Petite Saline Creek from adjacent Ozark/Moreau/Loutre EDU.

5.5 Physicochemical Data

In situ water quality measurements and turbidity are summarized in Table 6 (fall 2007) and Table 7 (spring 2008). Mean temperatures at Long Branch stations were 19.75°C and 6.0°C in the fall 2007 and spring 2008 surveys, respectively.

Conductivity levels were consistent among stations and between seasons. Dissolved oxygen levels were consistent between stations during the spring sampling and were generally higher during the spring than fall. During the fall however, dissolved oxygen levels were noticeably lower than those in the spring. Dissolved oxygen during the spring did not fall below the Water Quality Standards minimum concentration for warm-water and cool-water fisheries (5.0 mg/L). Dissolved oxygen levels during the fall season did fall below the minimum concentration. Typically dissolved oxygen levels are higher during the spring season when water temperatures are cooler.

Turbidity levels were consistent between stations within seasons. During the spring, turbidity values were higher than they were during the fall, likely because of runoff from spring rains.

Table 6
In situ Water Quality Measurements and Turbidity at all Stations (Fall 2007)

Station	Parameter				
	Temp. (ºC)	Diss. O_2 (mg/L)	Cond. (µmhos/cm)	pH	Turb. (NTU)
Long Branch 1	17.5	4.33	427	8.2	8.46
Long Branch 2	22.0	1.74	437	7.6	6.96

Table 7
In situ Water Quality Measurements and Turbidity at all Stations (Spring 2008)

Station	Parameter				
	Temp. (ºC)	Diss. O_2 (mg/L)	Cond. (µmhos/cm)	pH	Turb. (NTU)
Long Branch 1	7.0	10.68	391	7.8	33.8
Long Branch 2	5.0	9.87	402	7.5	38.3

Nutrient and chloride concentrations are presented in Table 8 (fall 2007) and Table 9 (spring 2008). Ammonia, nitrate + nitrite, and total nitrogen concentrations were generally higher during the spring season. Chloride levels were consistent between stations and seasons. All chloride levels were below chronic criteria for protection of aquatic life and drinking water supply.

Table 8
Nutrient Concentrations at all Stations (Fall 2007)

Station	Sample #	Parameter (mg/L)				
		NH_3-N	$NO_3 + NO_2$-N	Total N	Total P	Chloride
Long Branch 1	0710283	0.07	0.28	0.78	0.08	8.14
Long Branch 2	0710282	<0.03	0.04	0.53	0.05	17.8

Table 9
Nutrient Concentrations at all Stations (Spring 2008)

Station	Sample #	Parameter (mg/L)				
		NH_3-N	$NO_3 + NO_2$-N	Total N	Total P	Chloride
Long Branch 1	0803425	0.32	1.06	2.26	0.14	24.2
Long Branch 2	0803426	0.04	0.59	1.35	0.05	18.1

5.6 Biological Assessment

5.6.1 Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (SMSBPP)

The SMSBPP evaluation used biological criteria that were calculated from ESP's database of Wadeable/Perennial Biological Reference Stream criteria for the Central Plains/Blackwater/Lamine EDU. See Biological Criteria for Wadeable/Perennial Streams of Missouri (MDNR 2002a) for more explanation. These criteria are listed for fall and spring seasons in Tables 10 and 11 respectively. Macroinvertebrate Stream Condition Index sustainability scores of 20-16 qualify as fully sustaining, 14-10 as partially sustaining, and 8-4 as non-sustaining of aquatic life.

Table 10
Biological Criteria for Warm Water Reference Streams in the Central Plains/Blackwater/Lamine EDU (Fall Season)

	Score = 5	Score = 3	Score = 1
TR	>54	27-54	<27
EPTT	>5	3-5	<3
BI	<7.6	7.6-8.9	>8.9
SDI	>2.86	1.43-2.84	<1.43

Table 11
Biological Criteria for Warm Water Reference Streams in the Central Plains/Blackwater/Lamine EDU (Spring Season)

	Score = 5	Score = 3	Score =1
TR	>49	25-49	<25
EPTT	>7	4-7	<4
BI	<7.5	7.5-8.7	>8.7
SDI	>2.52	1.27-127	<1.27

5.6.2 Comparisons with Regional Reference Streams in the Central Plains/Blackwater/Lamine EDU

Macroinvertebrate Stream Condition Indices were calculated for Long Branch as derived from biological criteria from Central Plains/Blackwater/Lamine EDU reference streams. The four metrics, total scores, and MSCI sustainability rankings during fall 2007 and spring 2008 are presented in Tables 12 and 13 respectively.

Table 12
Long Branch Metric Values and Stream Condition Indices, Fall 2007 Sampling Season

Station	Sample #	TR	EPTT	BI	SDI	MSCI	Sustainability
Long Branch 1	0703287	59	3	7.7	3.12	16	**Full**
Long Branch 2	0703286	42	2	8.0	2.47	10	**Partial**

Table 13
Long Branch Metric Values and Stream Condition Indices, Spring 2008 Sampling Season

Station	Sample #	TR	EPTT	BI	SDI	MSCI	Sustainability
Long Branch 1	0804002	44	2	8.3	2.51	10	**Partial**
Long Branch 2	0804003	48	2	8.2	2.85	12	**Partial**

5.6.3 Long Branch Longitudinal Comparison

There are no significant differences between MSCI scores and metrics longitudinally for the spring sampling season when both stations received a “partially” sustainable ranking. There is a notable difference longitudinally during the fall season when Long Branch 1 received an MSCI score of 16 with a “fully” sustainable rating and Long Branch 2 received an MSCI of only 10 with a “partially” sustainable rating.

5.6.4 Long Branch Seasonal Comparisons

There was no seasonal difference between Long Branch 2 during the fall and both stations during the spring which all received a “partially” sustainable rating. During the fall season Long Branch 1 ranked higher with a “fully” sustainable rating.

5.6.5 Macroinvertebrate Percent and Community Composition

Macroinvertebrate taxa richness, EPT taxa, percent EPT relative abundance, and top five dominant families are presented in Table 14 for the fall sampling season and Table 15 for the spring sampling season. The percent of relative abundance data were averaged from the sum of the three macroinvertebrate habitats (depositional non-flow, woody debris, and rootmat) sampled at each station.

Diptera was the dominant order (>50%) at both stations during the spring season and at Long Branch 1 during the fall season, but Tubificida was the most abundant order during the fall season at Long Branch 2. None of the three EPT orders were well represented at either sampling station during either season.

Table 14
Fall 2007 Macroinvertebrate Composition (percentages rounded to whole numbers)

Station	1	2
Taxa Richness	59	42
EPTT	3	2
% Ephemeroptera	1	15
% Plecoptera	0	0
% Trichoptera	0	0
Total EPT %	1	15
% Diptera	60	15
% Tubificida	7	29
% Top Five Dominant Families		
Chironomidae	57	12
Tubificidae	7	29
Asellidae	7	
Physidae	6	
Elmidae	4	9
Caenidae		14
Planorbidae		13

Table 15
Spring 2008 Macroinvertebrate Composition (percentages rounded to whole numbers)

Station	1	2
Taxa Richness	44	48
EPTT	2	2
% Ephemeroptera	1	5
% Plecoptera	0	0
% Trichoptera	0	0
Total EPT %	1	5
% Diptera	59	60
% Top Five Dominant Families		
Chironomidae	58	59
Asellidae	18	
Tubificidae	10	16
Cambaridae	3	
Crangonyctidae	3	
Caenidae		5
Hyalellidae		3
Asellidae		3

6.0 Discussion

Other than low dissolved oxygen levels during the fall season, physicochemical results revealed few definitive trends other than typical seasonal differences. In spite of the lower dissolved oxygen levels in the fall, Long Branch 1 was the only sample to receive a "fully" sustainable rating that season. The two spring samples received "partially" sustainable ratings when dissolved oxygen levels were adequate. There are several potential causes for the three macroinvertebrate community samples that received "partially" sustainable ratings.

One possibility is the relatively small size of the stream sampling stations compared to BIOREF stations. Channel measurements for average channel width, average wetted width, and average depth fall well below the ranges of those dimensions for the four BIOREF stations. Also, Long Branch 2 is in the class "C" section of stream being compared with predominantly class "P" BIOREF stations.

Even though the SHAPP scores met the 75% threshold for overall scores at both stations, available epifaunal substrate was lacking, especially at Long Branch 1. In the epifaunal substrate category of the habitat assessment, Long Branch 2 was in the "marginal" category and Long Branch 1 was in the "poor" category scoring a 2 out of 20. The epifaunal substrate in the BIOREF stream also received a poor rating; however a lower percentage of epifaunal substrate in a smaller stream will provide less overall available

substrate than a larger steam with a similar percentage of epifaunal substrate. At Long Branch 2, even though the normal method for determining channelization fails to indicate the steam is channelized, it is apparent by the shape of the stream segment combined with the extensive rip rap that it has been altered by channelization.

Other possible causes of impairment are discussed in section 2.1. Water and stream quality concerns discussed include potential runoff from the WAFB as well as agricultural impacts and a chicken egg CAFO at Long Branch 1.

Fluctuations in precipitation amounts throughout the study period could have also had an effect. The time prior to the fall season was an unusually dry period. This dry period could at least be partially responsible for the low dissolved oxygen levels at both stations. Just prior to the spring sampling the area had experienced a considerable amount of heavy rains which could have caused a scour event. Where epifaunal habitat is limited and macroinvertebrates have relatively few places to harbor during high discharge events, the effect can be more pronounced.

Since the source of discharge from under the airfield at WAFB is undetermined, it is difficult to determine what water quality impairment(s), if any, could exist without further study.

7.0 Conclusions and Summary

Based on this study, a conclusion may be drawn that Long Branch is biologically impaired by unknown source(s).

- The null hypothesis that macroinvertebrate assemblages are similar between Long Branch and reference streams in the same EDU is rejected for all samples except station #1 during the fall season.
- The null hypothesis that macroinvertebrate assemblages between Long Branch segments is accepted for the spring sampling season and rejected for the fall sampling season.
- The null hypothesis that macroinvertebrate assemblages will not differ significantly between the two sample seasons is accepted for Long Branch 2 and rejected for Long Branch 1.
- The null hypothesis that habitat quality among Long Branch segments is similar is accepted.
- The null hypothesis that Long Branch habitat quality is similar between Long Branch and biocriteria reference streams is accepted based on SHAPP scores.

The null hypothesis that accepts habitat quality as similar between Long Branch and the BIOREF is based on the SHAPP scores and channel measurement results showing ratios and depth heterogeneity. However habitat issues exist in Long Branch that have the potential to affect macroinvertebrate communities (see Sec. 6.0).

8.0 Recommendations

Since this study indicates possible impairment by unknown sources, a stressor study should be performed to determine the source(s) of any possible impairment and determine if it is caused by more than limited stream size, lack of instream substrate, and/or fluctuating discharge levels.

One step in determining if water quality is an issue affecting aquatic life is to conduct toxicity analysis of water and sediment samples from Long Branch. If those results indicate instream toxicity, further study should be conducted to determine the source and component chemicals of the toxicity.

Any further biological assessment studies of Long Branch that include the class "C" section should be compared exclusively with biological criteria and habitat measurements derived from a similar class of streams in the same EDU.

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Appendix A

Proposed Bioassessment Study Plan Long Branch July 19, 2007

Missouri Department of Natural Resources
Bioassessment Study Plan
Long Branch, Johnson and Pettis Counties
July 19, 2007

Objective

This study will characterize the macroinvertebrate communities in Long Branch at two sites within the 3.5 miles of 303(d) listed section to determine if the stream is impaired and justifies continued 303(d) listing. The objective of this study is to determine if aquatic macroinvertebrate life is impaired along the listed section of Long Branch.

Null Hypotheses

1). Macroinvertebrate communities in Long Branch will not differ significantly from macroinvertebrate communities in similar sized reaches of reference streams within the Central Plains/Blackwater/Lamine Ecological Drainage Unit (**EDU**).

2). Macroinvertebrate communities will not differ significantly between the two longitudinally separate reaches of Long Branch.

3). Macroinvertebrate communities will not differ significantly between the two sample seasons.

Background

Long Branch begins just south of Whiteman Air Force Base (**WAFB**) in eastern Johnson County and flows through the southern boundary of WAFB. From there it flows into western Pettis County where it joins Muddy Creek just south of La Monte. During a July 18, 2007 reconnaissance for this study, the streambed of Long Branch just upstream of the airfield at WAFB was dry and covered with terrestrial vegetation. At the upstream side of the airfield, the streambed ran into a culvert along the western edge of the southern portion of the airfield. Where the streambed emerged from the culvert at the eastern edge of the airfield, it had flow of an estimated 0.25 to 0.50 cubic feet per second (**cfs**). It is uncertain as to the source of the water coming from the culvert. A three and a half (3.5) mile segment from W ½ Sec. 6, T 45 N, R 23 W to W ½ Sec. 9, T 45 N, R 24 W (see attachment) is listed on the 303(d) list as impaired by unknown causes. Streams may become listed by U. S. Environmental Protection Agency (**EPA**) for unknown causes for a variety of reasons. The goal of this study is to evaluate the listed segment of Long Branch for impairment. If impairment is not demonstrated, rationale will be provided for removing Long Branch from the 303(d) list.

Study Design

General: Two Long Branch stations will be surveyed. The site locations are: Station 1) just downstream of the Thompson Road crossing on the Pettis County side of the line with Johnson County with GPS coordinates Lat. 38.71729º, Long. –93.50414º at the upstream terminus; and

Station 2) at WAFB in the southeast corner of the property with GPS coordinates Lat. 38.71737, Long. –93.53442 at the downstream terminus.

At each station, the length sampled will extend 20 times the average stream width as outlined in MDNR-WQMS-032 (MDNR 2003b). To assess comparability between sampling stations and reference streams, stream discharge, habitat assessment and water chemistry will be determined during macroinvertebrate surveys. Sampling will be conducted during the fall of 2007 (mid September through mid October) and the spring of 2008 (mid March through mid April).

Biological Sampling Methods: Macroinvertebrates will be sampled as per the guidelines of the Semi-Quantitative Macroinvertebrate Stream Bioassessment Project Procedure (**SMSBPP**) (MDNR 2003a). Long Branch will be considered a "glide/pool" predominant stream; therefore samples will be collected from flow over depositional (non-flow), root-mat, and wood debris (snag) habitats. Each macroinvertebrate sample will be a composite of six subsamples, except for woody debris, which is a composite of twelve.

Habitat Sampling Methods: A standardized habitat procedure for Glide/Pool stream types will be followed in the Stream Habitat Assessment Project Procedure (**SHAPP**) guidelines of MDNR-FSS-032 (MDNR 2003b). Stream channel dimensions will also be measured at each sampling station where a series of ten bank to bank transects will be established. Each transect will be equally spaced within the sampling reach, which was 20x the average width. Measurements taken at each transect will include lower bank width (see SHAPP for a definition of lower bank), wetted width, and water depth at 1/3, 1/2, and 2/3 of the distance across the wetted width.

Water Quality Sampling Methods: Stream discharge will be measured at each sampling location using a Marsh-McBirney flow meter. Water samples from all sampled stations will be analyzed at the ESP laboratory for ammonia, nitrogen as NO_2 +NO_3, total nitrogen, total phosphorus, chloride and turbidity. Field measurements will include pH, conductivity, temperature and dissolved oxygen.

Laboratory Methods: All samples of macroinvertebrates will be processed and identified per MDNR-FSS-209, Taxonomic Levels for Macroinvertebrate Identification (MDNR 2005). Turbidity samples will be analyzed at the MDNR biological laboratory.

Data Recording and Analyses: Macroinvertebrate data will be entered in a Microsoft Access database in accordance with MDNR-WQMS-214, Quality Control Procedures for Data Processing (MDNR 2003c). Data analysis is automated within the Access database. Four standard metrics are calculated according to the SMSBPP: Total Taxa (TT); Ephemeroptera, Plecoptera, Trichoptera Taxa (EPTT); Biotic Index (BI); and the Shannon Index (SI) will be calculated for each reach.

Macroinvertebrate data will be analyzed in two ways. First, a longitudinal comparison between the three Long Branch reaches will be performed. Secondly, the data from the Long Branch sites will be compared to biological criteria from wadeable/perennial reference streams with similar geology and watershed size classification.

Data Reporting: Results of the study will be summarized and interpreted in report format.

Quality Control: As stated in the various MDNR Project Procedures and Standard Operating Procedures.

References:

Missouri Department of Natural Resources. 2003a. Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure. MDNR-FSS-030. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 24 pp.

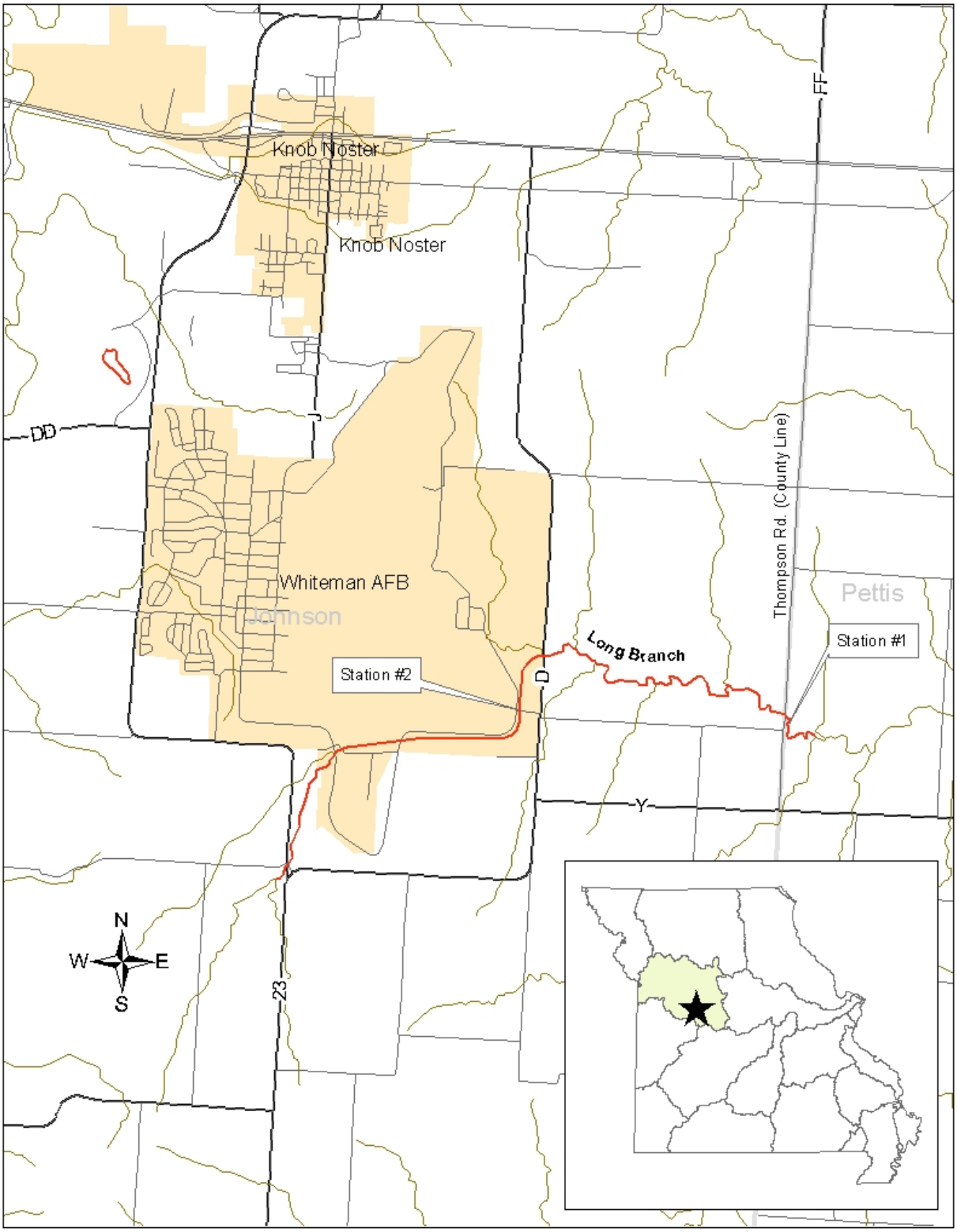
Missouri Department of Natural Resources. 2003b. Stream Habitat Assessment Project Procedure (SHAPP). MDNR-FSS-032. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 40 pp.

Missouri Department of Natural Resources. 2005. Taxonomic Levels for Macroinvertebrate Identifications. MDNR-WQMS-209. Missouri Department of Natural Resources, Environmental Services Program, P. O. Box 176, Jefferson City, MO 65102. 30 pp.

Missouri Department of Natural Resources. 2003c. Quality Control Procedures for Data Processing. MDNR-WQMS-214. Missouri Department of Natural Resources, Environmental Services Program, P. O. Box 176, Jefferson City, MO 65102. 6 pp.

Attachments

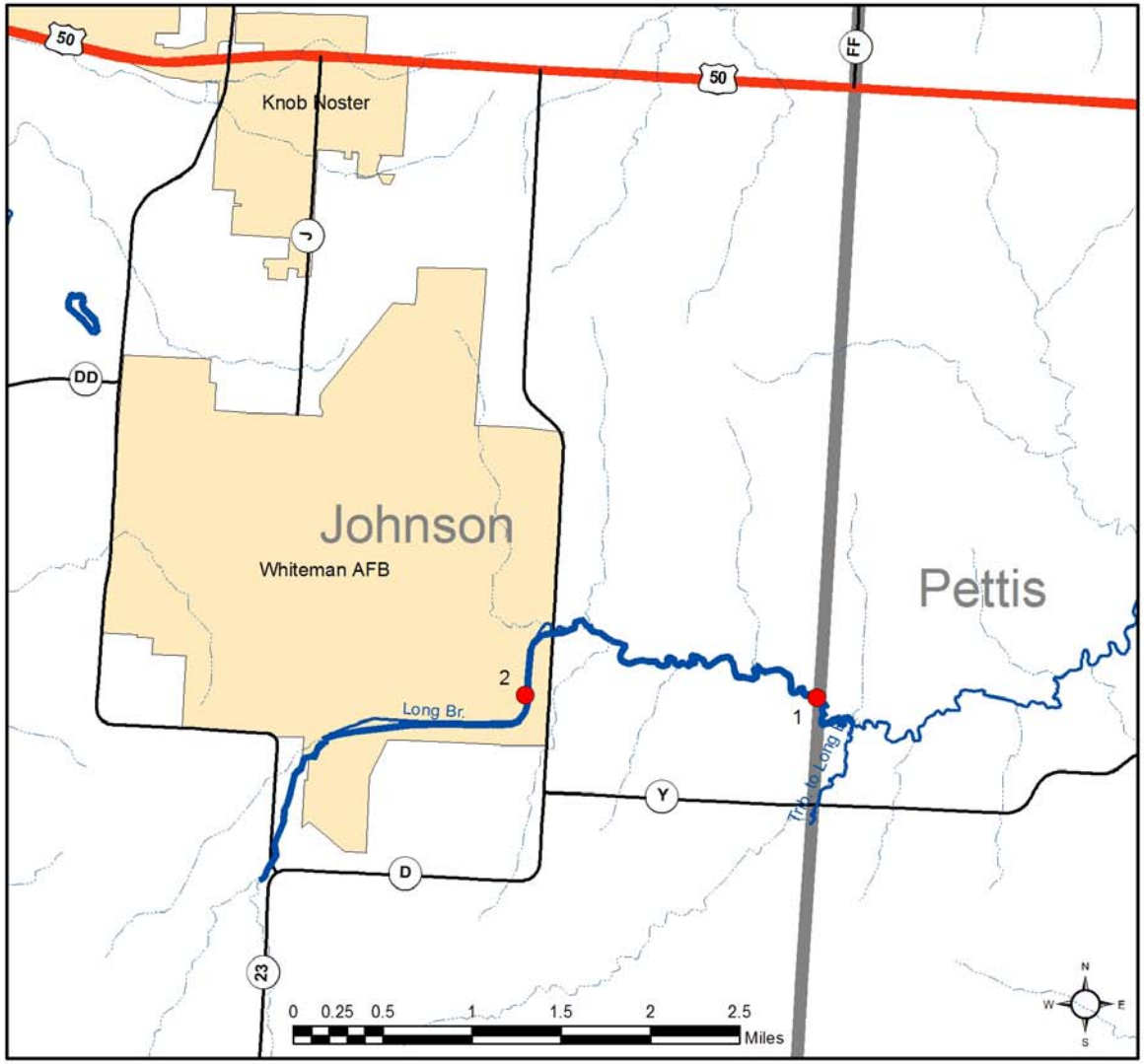
Map of all sampling stations in this study

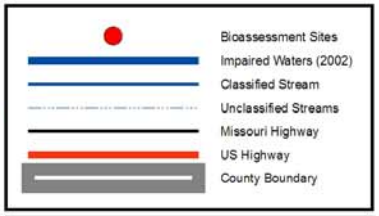


Appendix B

Long Branch Study Area Map

Long Branch Study Area





Bioassessment
Sampling Site Location

Ecolocial Drainage Unit (EDU) - An EDU is an area that contains a unique combination of habitats and organisms. Missouri is divided into 19 EDUs as shown in the inset map below. This site is located in the highlighted EDU.

Ecological Drainage Unit

Appendix C

Long Branch Macroinvertebrate Bench Sheets

Aquid Invertebrate Database Bench Sheet Report
Long Branch [0703287], Station #1, Sample Date: 9/27/2007 10:10:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	3	10	
AMPHIPODA			
Hyalella azteca		12	
ARHYNCHOBDELLIDA			
Erpobdellidae	1		
BRANCHIOBDELLIDA			
Branchiobdellida	2	3	
COLEOPTERA			
Dubiraphia	4	27	1
Helichus basalis		2	1
Helochares			1
Neoporus	1	3	1
Scirtidae		10	15
DECAPODA			
Orconectes virilis	2	-99	
Palaemonetes kadiakensis		1	
DIPTERA			
Anopheles		2	
Ceratopogoninae	6		
Chironomus	35	3	
Cladotanytarsus	3		
Cryptochironomus	1		
Dicrotendipes	2	2	13
Diptera	4		
Dolichopodidae		2	
Forcipomyiinae			5
Glyptotendipes	17	19	17
Goeldichironomus		1	
Hemerodromia	1		
Microtendipes	2	3	1
Nanocladius		1	
Nilotanypus		1	
Parachironomus	1	6	
Paralauterborniella	1	1	
Parametriocnemus		1	
Paratanytarsus		68	
Paratendipes	3	1	
Polypedilum fallax grp			1
Polypedilum halterale grp	35		
Polypedilum illinoense grp	7	19	1
Procladius	20	1	1
Psychoda		1	
Stenochironomus	2	1	
Tanypus	1		
Tanytarsus	50	65	9
Thienemanniella		1	
Thienemannimyia grp.		1	

Aquid Invertebrate Database Bench Sheet Report
Long Branch [0703287], Station #1, Sample Date: 9/27/2007 10:10:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Tipula	7	1	
EPHEMEROPTERA			
Caenis latipennis	2	3	2
Stenacron			3
HEMIPTERA			
Corixidae		1	
Notonecta		1	
Trepobates		1	
ISOPODA			
Lirceus	7	29	13
LIMNOPHILA			
Ancylidae		11	
Lymnaeidae		1	
Menetus		8	
Physella	9	31	7
MEGALOPTERA			
Sialis	1		
ODONATA			
Argia		1	
Enallagma		1	
Ischnura		2	
TRICHOPTERA			
Oecetis	1		
TUBIFICIDA			
Tubificidae	51	4	
VENEROIDEA			
Sphaeriidae	1		

Aquid Invertebrate Database Bench Sheet Report
Long Branch [0703286], Station #2, Sample Date: 9/25/2007 10:10:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	1	3	2
AMPHIPODA			
Hyalella azteca		74	
ARHYNCHOBDELLIDA			
Erpobdellidae	1		
BRANCHIOBDELLIDA			
Branchiobdellida	2	1	
COLEOPTERA			
Dubiraphia	26	50	
Neoporus			1
Scirtidae	1	16	7
DECAPODA			
Orconectes virilis	2	-99	
DIPTERA			
Ablabesmyia	1		
Anopheles	1	3	1
Chironomus	8		1
Corynoneura			1
Dicrotendipes	3	1	14
Einfeldia			1
Forcipomyiinae			26
Glyptotendipes			17
Labrundinia		2	
Parachironomus		1	
Paratanytarsus	4	9	
Paratendipes	1		1
Polypedilum illinoense grp	2	1	
Procladius	21	1	
Tanypus	1		
Tanytarsus	1	1	
Thienemannimyia grp.	4	1	
EPHEMEROPTERA			
Caenis latipennis	105	2	12
Stenacron	1	2	3
HEMIPTERA			
Belostoma		-99	
Trepobates		3	
ISOPODA			
Lirceus		1	
LIMNOPHILA			
Ancylidae	4	7	5
Helisoma		-99	
Menetus	1	109	1
Physella		5	3
MEGALOPTERA			
Sialis	1		
ODONATA			

Aquid Invertebrate Database Bench Sheet Report
Long Branch [0703286], Station #2, Sample Date: 9/25/2007 10:10:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
Argia		1	
Ischnura		7	
Libellulidae			1
Pachydiplax longipennis		1	
Perithemis	1		
TUBIFICIDA			
Tubificidae	232		14
VENEROIDEA			
Sphaeriidae	9		1

Aquid Invertebrate Database Bench Sheet Report
Long Branch [0804002], Station #1, Sample Date: 3/24/2008 12:00:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
AMPHIPODA			
Crangonyx		15	1
Hyalella azteca	1		
ARHYNCHOBDELLIDA			
Erpobdellidae	-99		
BRANCHIOBDELLIDA			
Branchiobdellida	2		1
COLEOPTERA			
Dubiraphia		2	
Helichus basalis		1	
Hydroporus		2	
Scirtidae		1	
Stenelmis	1		
DECAPODA			
Orconectes	11	5	1
Orconectes virilis	-99		1
DIPTERA			
Ablabesmyia		1	
Ceratopogoninae	3		
Chironomus	3		1
Cricotopus/Orthocladius	1	35	3
Dicrotendipes	2	1	5
Diplocladius		1	
Glyptotendipes	14	12	8
Hydrobaenus	27	125	20
Mesosmittia	1		
Parametriocnemus			1
Paratanytarsus			9
Polypedilum halterale grp	13		
Polypedilum illinoense grp	4	1	4
Procladius	14		
Pseudosmittia			1
Stenochironomus			3
Tanytarsus	1	4	1
Thienemannimyia grp.		1	
Tipula	1		
EPHEMEROPTERA			
Caenis latipennis		3	
ISOPODA			
Lirceus	1	90	5
LIMNOPHILA			
Lymnaeidae	1		2
Menetus		1	
Physella	-99	5	
ODONATA			
Somatochlora			-99
RHYNCHOBDELLIDA			
Glossiphoniidae	1		

Aquid Invertebrate Database Bench Sheet Report
Long Branch [0804002], Station #1, Sample Date: 3/24/2008 12:00:00 PM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
TRICHOPTERA			
Cheumatopsyche		-99	
TRICLADIDA			
Planariidae		6	
TUBIFICIDA			
Enchytraeidae		6	
Limnodrilus claparedianus	1		1
Limnodrilus hoffmeisteri	1	1	4
Tubificidae	30	16	3
VENEROIDEA			
Sphaeriidae	3		

Aquid Invertebrate Database Bench Sheet Report
Long Branch [0804003], Station #2, Sample Date: 3/24/2008 10:15:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
"HYDRACARINA"			
Acarina	1	8	
AMPHIPODA			
Crangonyx		11	
Hyalella azteca	1	19	10
ARHYNCHOBDELLIDA			
Erpobdellidae	1		
BRANCHIOBDELLIDA			
Branchiobdellida	2	6	
COLEOPTERA			
Dubiraphia	4	18	2
Neoporus	1	6	1
Peltodytes	1		
Scirtidae		5	
Tropisternus		-99	
DECAPODA			
Orconectes virilis	-99	-99	
DIPTERA			
Ceratopogoninae	9		2
Chironomidae	3	4	
Chironomus	4		4
Cladopelma	2		
Cricotopus/Orthocladius	3	68	77
Dicrotendipes	3	3	54
Diptera			1
Glyptotendipes		5	12
Hydrobaenus	27	53	76
Microtendipes	1		
Parachironomus		3	
Parametriocnemus	1	2	1
Paratanytarsus	2	38	16
Polypedilum halterale grp	19		2
Polypedilum illinoense grp	1		
Procladius	83		2
Stictochironomus	3	1	
Tanypus	1		
Tanytarsus	1	2	6
Thienemannimyia grp.	1		2
EPHEMEROPTERA			
Caenis latipennis	10	22	18
Stenacron			1
ISOPODA			
Lirceus		22	6
LIMNOPHILA			
Ancylidae		1	2
Lymnaeidae		1	4
Menetus	1	11	6
Physella	1	7	11

Aquid Invertebrate Database Bench Sheet Report
Long Branch [0804003], Station #2, Sample Date: 3/24/2008 10:15:00 AM
NF = Nonflow; RM = Rootmat; SG = Woody Debris; -99 = Presence

ORDER: TAXA	NF	RM	SG
MEGALOPTERA			
Sialis	-99		
ODONATA			
Ischnura		4	
Nasiaeschna pentacantha		1	
RHYNCHOBDELLIDA			
Glossiphoniidae			1
TRICLADIDA			
Planariidae			1
TUBIFICIDA			
Enchytraeidae		1	
Limnodrilus claparedianus	21		
Limnodrilus hoffmeisteri	1		
Tubificidae	121	5	10
VENEROIDEA			
Sphaeriidae			3